Slate River and Rock Island Creek Bacteria Total Maximum Daily Load Implementation Plan

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EXECUTIVE SUMMARY

Introduction

The Virginia Total Maximum Daily Load (TMDL) program is a process to improve water quality and restore impaired waters in Virginia. Specifically, TMDL is the maximum amount of pollutant that a waterbody can assimilate without surpassing the state water quality standards for protection of the five beneficial uses: drinking water, recreational (i.e., primary contact/swimming), fishing, shellfishing, and aquatic life.

Frisby Branch, North River, Upper Slate River, and Lower Slate River were initially placed on the Commonwealth of Virginia's Section 303(d) List of Impaired Waters in 2002 for exceedances of the bacteria standard. Rock Island Creek, Austin Creek, and Troublesome Creek were initially listed in 2004. After these listings, a TMDL study was conducted to identify bacteria sources in the watersheds. After these TMDLs were developed, Muddy Creek and Turpin Creek were listed as impaired due to exceedances of the bacteria standard. These watersheds drain to the Lower Slate River watershed, were assigned load reductions as part of TMDL development for the Lower Slate River impairment, and are included as part of the implementation plan.

After a TMDL study is complete and approved by the United States Environmental Protection Agency, Virginia's 1997 Water Quality Monitoring, Information and Restoration Act states in section 62.1-44.19:7 that the "Board shall develop and implement a plan to achieve fully supporting status for impaired waters". To comply with this state requirement, a TMDL implementation plan was developed to reduce bacteria levels to attain water quality standards allowing delisting of streams from the Section 303(d) List of Impaired Waters. The TMDL implementation plan describes control measures, which can include the use of better treatment technology and the installation of best management practices, to be implemented in a staged process.

Key components of the implementation plan are discussed in the following sections:

- **Review of TMDL Development Study**
- **Public Participation**
- **Implementation Actions**
- **Measurable Goals and Milestones for Attaining Water Quality Standards**
- **Stakeholder's Roles and Responsibilities**
- **Integration with Other Watershed Plans**
- **Potential Funding Sources**

Review of TMDL Study

Impairment description, water quality monitoring, watershed description, source assessment, water quality modeling, and allocated reductions were reviewed to determine implications of TMDL and modeling procedures on implementation plan development. Conditions outlined in the TMDL development study to address the bacteria impairments in the Slate River and Rock Island Creek watersheds include:

- Exclusion of most/all livestock including horses from streams is necessary;
- Substantial land-based NPS load reductions are called for on pasture and cropland;
- All straight pipes and failing septic systems need to be identified and corrected;
- Implicit in the requirement to correct straight pipes and failing septic systems is the requirement to maintain all properly functioning septic systems;
- Reductions to pet bacteria loads on residential land use are necessary; and
- Implicit in the requirement for no point source bacteria load adjustment is the requirement for point sources to maintain permit compliance.

Public Participation

The actions and commitments compiled in this document are formulated through input from citizens of the watershed; Buckingham County government; Peter Francisco Soil and Water Conservation District; Virginia Department of Conservation and Recreation; Virginia Department of Environmental Quality; Virginia Department of Health; Natural Resources Conservation Service; Virginia Department of Corrections; and Blue Ridge Environmental Solutions, Inc.

Public participation took place during implementation plan development on three levels. First, public meetings were held to provide an opportunity for informing the public as to the end goals and status of the project, as well as, a forum for soliciting participation in the smaller, more-targeted meetings (*i.e.*, working groups and Steering Committee). Second, three working groups were formed: Agricultural, Residential, and Governmental. Third, a Steering Committee was formed with representation from the Agricultural, Residential, and Governmental Working Groups; Buckingham County; Peter Francisco Soil and Water Conservation District; Virginia Department of Conservation and Recreation; Virginia Department of Health; Virginia Department of Environmental Quality; Natural Resources and Conservation Service; Virginia Department of Corrections; and Blue Ridge Environmental Solutions, Inc. to guide the development of the implementation. Over 160 man-hours were devoted to attending these meetings by individuals representing agricultural, residential, commercial, environmental, and government interests on a local, state, and federal level. Throughout the public participation process, major emphasis was placed on discussing best management practices (BMPs), locations of control measures, education, technical assistance, monitoring, and funding.

Implementation Actions

The quantity of control measures, or BMPs, required during implementation was determined through spatial analyses of land use, stream-network, and the Commonwealth of Virginia aerial maps along with regionally appropriate data archived in the Virginia Department of Conservation and Recreation Agricultural BMP Database and TMDL document. Bacteria load reductions on land uses were determined through modeling alternative implementation scenarios, defining percentage of land use area or unit amount treated by control measure, then applying related reduction efficiency to the associated load. Additionally, input from local agency representatives, citizens, and contractors were used to verify the analyses.

Associated cost estimations for each implementation action were calculated by multiplying the average unit cost per the number of units. Focusing on Stage I (*i.e.*, removal of impairments from impaired waters list) costs, the total average installation cost for livestock exclusion systems and improved pasture management is $9.61 million. The total installation cost for converting cropland to permanent vegetative cover and forest is estimated at $0.02 million. Accordingly, total agricultural corrective action costs equal $9.63 million. Estimated corrective action costs needed to replace straight pipes and fix failing septic systems during Stage I totals $0.96 million. The cost to implement the first two steps of the pet waste reduction process totals an estimated eight thousand dollars. The total costs to provide assistance in the agricultural and residential programs during Stage I implementation are both expected to be $0.30 million. The total Stage I implementation cost including technical assistance is $11.19 million with the agricultural cost being $9.93 million and residential cost $1.26 million.

The primary benefit of implementation is cleaner waters in Virginia, where bacteria levels in the Slate River and Rock Island Creek impairments will be reduced to meet water quality standards, benefiting human and livestock herd health, stakeholder economy, and improve the aquatic community. An important objective of the implementation plan is to foster continued economic vitality and strength.

Measurable Goals and Milestones for Attaining Water Quality Standards

The end goals of implementation are restored water quality in the impaired waters and subsequent de-listing of streams from the Commonwealth of Virginia's Section 303(d) List of Impaired Waters. Progress toward end goals will be assessed during implementation through tracking of control measure installations. The Virginia Department of Environmental Quality will continue to assess water quality through its monitoring program. Implementation will be assessed based on reducing exceedances of the bacteria water quality standard, thereby improving water quality. Implementation of control measures is scheduled for 10 years and will be assessed in two stages. Stage I is based on meeting source allocations that translate to an instantaneous standard exceedance rate of 10.5% or less resulting in removal of streams from the Commonwealth of Virginia's Section 303(d) List of Impaired Waters. The Stage II goal is based on implementing source allocations to meet the specified TMDL goal, 0% exceedance of water quality standards. Monitoring data used in the 2010 impaired water assessment indicate a bacteria standard exceedance rate below 10.5% in Austin Creek, Frisby Branch, and Troublesome Creek. Strategy employed to address this potential improvement in water quality was to include control measure quantification for these watersheds and defer implementation of all control measures based on attainment of this water quality goal.

Implementation in years one through six for agricultural source reductions focuses on installing livestock stream exclusion systems, improving pasture management, and cropland conversion. BMPs installed in years seven through ten are based on additional treatment of bacteria load not treated during Stage I from pasture and cropland using improved pasture management, manure / biosolids incorporation into soil, and retention ponds. Implementation in years one through six for residential bacteria loads focuses on identification and removal of straight pipes, repairing or replacing failed septic systems, instituting pet waste control program, installation of pet waste enzyme digesting composters, and installation of storage and treatment systems for waste from confined canine units. Implementation of these control measures will continue in years seven through ten if needed.

Stakeholder's Roles and Responsibilities

Stakeholders are individuals who live or have land management responsibilities in the watershed, including government agencies, businesses, private individuals, and special interest groups. Successful implementation depends on stakeholders taking responsibility for their role in the process, and the primary role falls on the local groups that are most affected; that is, businesses, community watershed groups, and citizens. However, local, state, and federal agencies also have a stake in seeing that Virginia's waters are clean and provide a healthy environment for its citizens.

The Peter Francisco Soil and Water Conservation District will provide agricultural cost-share funds, lead education and technical assistance efforts, and track best management practice implementation for the agricultural and residential programs. State agencies conducting regulatory, education, or funding procedures related to water quality in Virginia include: Virginia Department of Environmental Quality; Virginia Department of Conservation and Recreation; Virginia Department of Health; Virginia Department of Agriculture and Consumer Services; Virginia Department of Game and Inland Fisheries; Virginia Department of Forestry; and Virginia Cooperative Extension. The Natural Resources Conservation Service will provide cost-share funds and technical assistance.

Integration with Other Watershed Plans

Each watershed within the state is under the jurisdiction of a multitude of individual yet related water quality programs and activities, many of which have specific geographical boundaries and goals. These include but are not limited to Chesapeake Bay 2000 agreement, Tributary Nutrient Reduction Plans, TMDLs, Roundtables, Water Quality Management Plans, Erosion and Sediment Control Regulations, Stormwater Management Program, Source Water Assessment Program, and local comprehensive plans. Financial and technical resources may be maximized for implementation by coordinating and expanding the planning and implementation activities of these on-going watershed projects or programs. Current initiatives within Buckingham County to be integrated with the Slate River and Rock Island Creek TMDL Implementation Plan include:

- Buckingham County Comprehensive Plan
- Middle James River Roundtable Strategic Plan
- James River Association Strategic Plan
- Willis River TMDL IP
- Chesapeake Bay Watershed Improvement Plan
- Virginia Wildlife Action Plan

Potential Funding Sources

Potential funding sources available during implementation were identified in the course of plan development. Detailed description of each source (*i.e.*, eligibility requirements, specifications, incentive payments) can be obtained from the Peter Francisco Soil and Water Conservation District; Virginia Department of Conservation and Recreation; Virginia Department of Health; Virginia Department of Environmental Quality; Virginia Department of Game and Inland Fisheries; Virginia Cooperative Extension; and Natural Resources Conservation Service.

INTRODUCTION

The Virginia Total Maximum Daily Load (TMDL) program is a process to improve water quality and restore impaired waters in Virginia. Specifically, TMDL is the maximum amount of pollutant that a water body can assimilate without surpassing the state water quality standards for protection of the five beneficial uses: drinking water, recreational (i.e., primary contact/swimming), fishing, shellfishing, and aquatic life. If the water body surpasses the water quality criteria during an assessment period, Section 303(d) of the Clean Water Act (CWA) and the United States Environmental Protection Agency's (USEPA) Water Quality Management and Planning Regulation (40 CFR Part 130) both require states to develop a TMDL for each pollutant.

Bacteria TMDLs have been developed for the Rock Island Creek, Austin Creek, Frisby Creek, North River, Troublesome Creek, Upper Slate River, and Lower Slate River impairments. After these TMDLs were developed, Muddy Creek and Turpin Creek were listed as impaired due to exceedances of the bacteria water quality standard. These watersheds drain to the Lower Slate River watershed, were assigned load reductions as part of TMDL development for the Lower Slate River impairment, and are included as part of the Slate River and Rock Island Creek TMDL Implementation Plan (IP).

Exclusion Fencing at North River

Frisby Branch, North River, Upper Slate River, and Lower Slate River were initially placed on the Commonwealth of Virginia's Section 303(d) List of Impaired Waters in 2002 for exceedance of the bacteria standard. Rock Island Creek, Austin Creek, and Troublesome Creek were initially listed in 2004. After these listings, a TMDL study was conducted to identify bacteria sources in the watersheds. The TMDL set limits on the amount of bacteria these rivers can tolerate and still maintain support of the Recreational Use.

A TMDL IP was developed to reduce bacteria levels to attain water quality standards allowing delisting of impaired waters from the Section 303(d) List. The TMDL IP describes control measures, which can include the use of better treatment technology and the installation of best management practices (BMPs), to be implemented in a staged process. Local support and successful completion of the implementation plan will enable restoration of the impaired water while enhancing the value of this important resource for the Commonwealth. Opportunities for Buckingham County, local agencies, and watershed residents to obtain funding will improve with an approved IP.

This public document is an abbreviated version of the technical document, which can be obtained by contacting the Virginia Department of Conservation and Recreation (VADCR) office.

STATE AND FEDERAL REQUIREMENTS FOR IMPLEMENTATION PLANS

In developing this implementation plan, both state and federal requirements and recommendations were followed. Virginia's 1997 WQMIRA directs the State Water Control Board (SWCB) to "develop and implement a plan to achieve fully supporting status for impaired waters" (§62.1-44.19:4 through 19:8 of the Code of Virginia). WQMIRA establishes that the implementation plan shall include the date of expected achievement of water quality objectives, measurable goals, corrective actions necessary and the associated costs, benefits, and environmental impacts of addressing the impairments.

Section 303(d) of the CWA and current USEPA regulations do not require the development of implementation strategies. USEPA does, however, outline the minimum elements of an approvable IP in its 1999 "Guidance for Water Quality-Based Decisions: The TMDL Process". The listed elements include description of the implementation actions and management measures, timeline for implementing these measures, legal or regulatory controls, time required to attain water quality standards, monitoring plan, and milestones for attaining water quality standards.

Slate River Watershed

USEPA develops guidelines that describe the process and criteria to be used to award CWA Section 319 nonpoint source grants to States. The "Supplemental Guidelines for the Award of Section 319 Nonpoint Source Grants to States and Territories in FY 2003" identifies the nine elements that must be included in the IP to meet the Section 319 requirements.

Once developed, Virginia Department of Environmental Quality (VADEQ) will present the IP to the SWCB for approval as the plan for implementing pollutant allocations and reductions contained in the TMDL. In addition, VADEQ will request the plan be included in the appropriate Water Quality Management Plan (WQMP), in accordance with the CWA's Section 303(e) and Virginia's Public Participation Guidelines for Water Quality Management Planning.

REVIEW OF TMDL DEVELOPMENT STUDY

Bacteria TMDLs for the Slate River and Rock Island Creek watersheds were completed in May 2007 with subsequent approval by USEPA in September 2007. The TMDL development document can be obtained at the VADEQ office in Lynchburg, VA or via the Internet at www.deq.virginia.gov. Impairment description, water quality monitoring, watershed description, source assessment, water quality modeling, and allocated reductions were reviewed to determine implications of TMDL and modeling procedures on IP development.

Straight Pipe

The Rock Island Creek and Slate River watersheds, comprising National Watershed Boundary Dataset (NWBD) JM43 and JM51-JM57, are located in Buckingham County, Virginia in the James River basin (Figure 1). The Slate River watershed of approximately 156,940 acres is comprised of forest (87%), pasture/cropland (10%), water/wetland (2%), and residential (1%) land uses. The Rock Island Creek watershed area is approximately 13,050 acres with forest as the primary land use (92%) followed by pasture/cropland (6%), water/wetland (2%), and residential (1%) land uses (Figure 2).

Failed Septic System

Potential sources of fecal coliform bacteria include both point source and nonpoint source (NPS) contributions. Nonpoint sources include: wildlife, grazing livestock, land application of manure and biosolids, urban/residential runoff, failed and malfunctioning septic systems, and uncontrolled discharges (straight pipes). The Hydrologic Simulation Program - Fortran (HSPF) model was used to simulate runoff and bacteria loads within the watershed. Conditions outlined in the TMDL development study to address the bacteria impairments in the Slate River and Rock Island Creek watersheds include:

- ★ Exclusion of most/all livestock including horses from streams is necessary;
- ★ Substantial land-based NPS load reductions are called for on pasture and cropland;
- ★ All straight pipes and failing septic systems need to be identified and corrected;
- ★ Implicit in the requirement to correct straight pipes and failing septic systems is the requirement to maintain all properly functioning septic systems;
- ★ Reductions to pet bacteria loads on residential land use are necessary; and
- ★ Implicit in the requirement for no point source bacteria load adjustment is the requirement for point sources to maintain permit compliance.

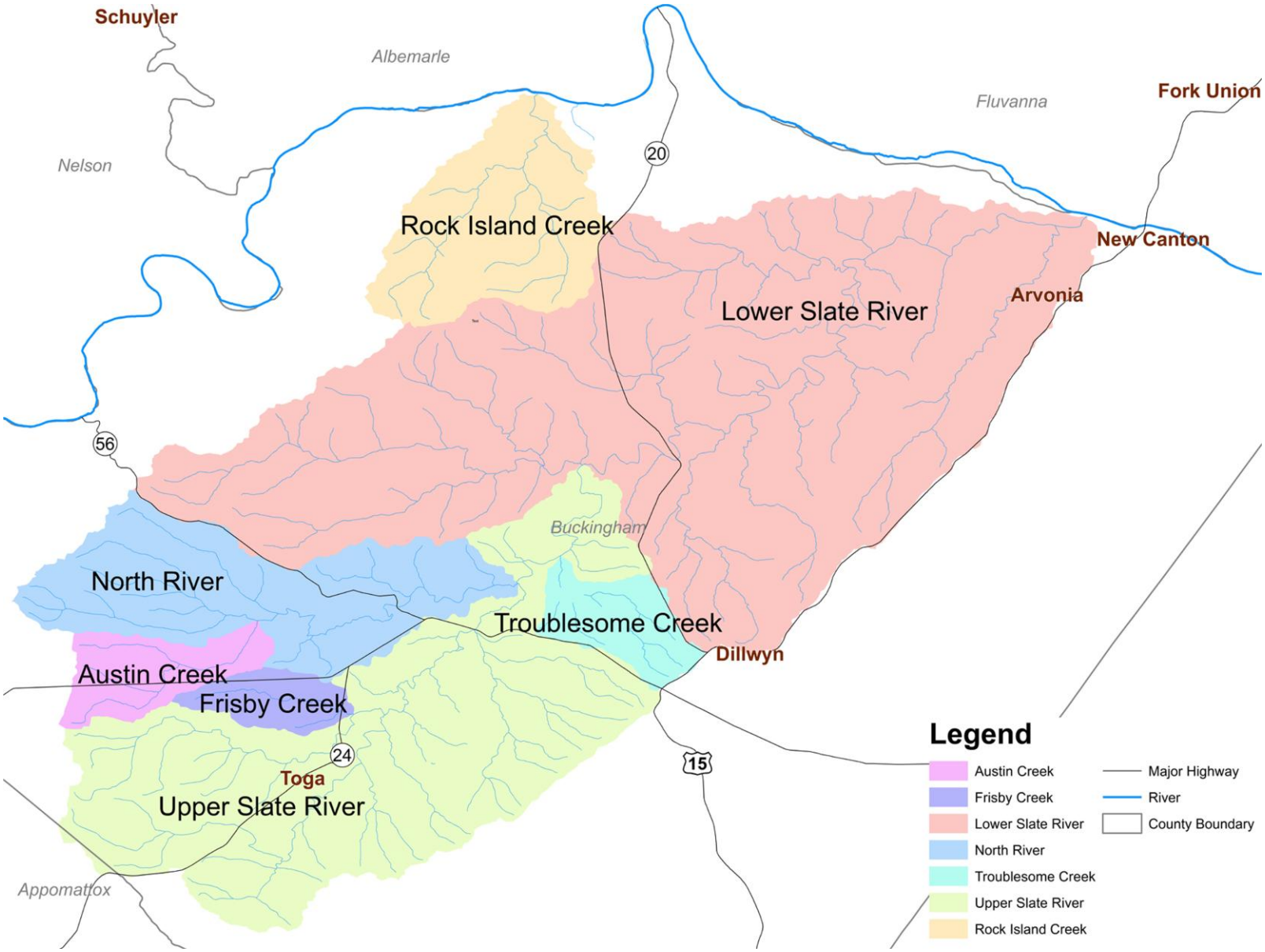


Figure 1. Slate River and Rock Island Creek watershed location.

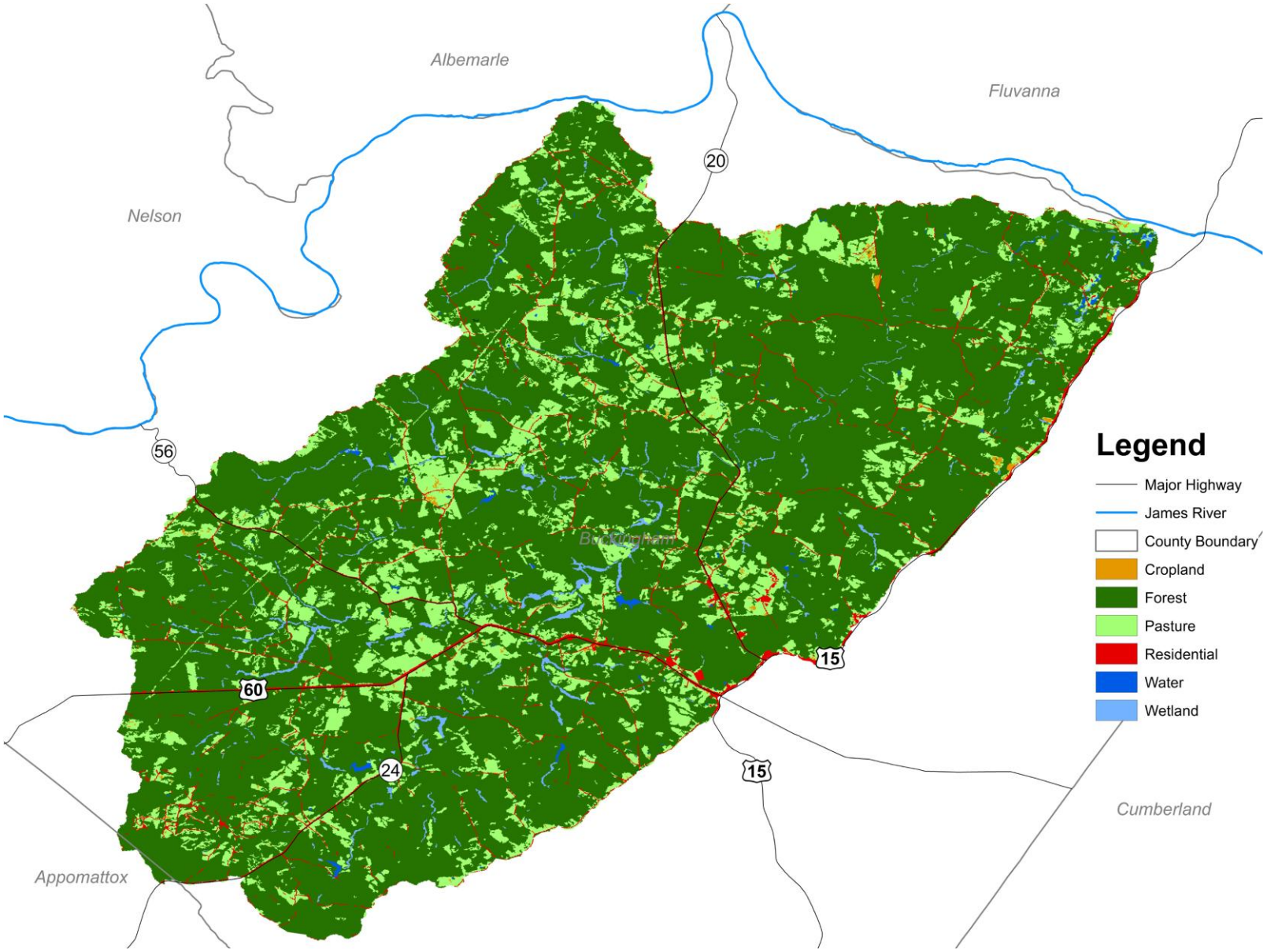


Figure 2. Land uses in the Slate River and Rock Island Creek watersheds.

PUBLIC PARTICIPATION

Process

The actions and commitments compiled in this document are formulated through input from citizens of the watershed; Buckingham County governments; Peter Francisco Soil and Water Conservation District (PFSWCD); VADCR; VADEQ; Virginia Department of Health (VDH); Natural Resources Conservation Service (NRCS); Virginia Department of Corrections (VADOC); and Blue Ridge Environmental Solutions, Inc. (BRES). Every citizen and interested party in the watershed is encouraged to put the IP into action and contribute what he or she is able to help restore the health of these waterbodies.

Public participation took place during IP development on three levels. First, public meetings were held to provide an opportunity for informing the public as to the end goals and status of the project, as well as, a forum for soliciting participation in the smaller, more-targeted meetings (*i.e.*, working groups and Steering Committee). Second, three working groups were formed: Agricultural, Residential, and Governmental. A representative from VADCR or BRES coordinated each working group in order to facilitate the process and integrate information collected from the various communities. Third, a Steering Committee was formed with representation from the Agricultural, Residential, and Governmental Working Groups; Buckingham County governments; PFSWCD; VADCR; VADEQ; VDH; NRCS; VADOC; and BRES to guide the development of the IP. Over 160 man-hours were devoted to attending these meetings by individuals representing agricultural, residential, commercial, environmental, and government interests on a local, state, and federal level (Table 1).

Livestock Stream Access

Pastured Livestock

Land Application

Table 1. Meetings held during the TMDL IP development process.

Date	Meeting Type	Location	Attendance	Time (hr)
04/22/10	Public Meeting	Buckingham Agricultural Center	24	1
04/22/10	Agricultural & Residential Working Group	Buckingham Agricultural Center	21	1
06/08/10	Governmental Working Group	Buckingham USDA Service Center	6	2
08/23/10	Agricultural & Residential Working Group	Buckingham USDA Service Center	10	2
10/07/10	Steering Committee	Buckingham USDA Service Center	6	2
10/20/10	Public Meeting	Buckingham Agricultural Center	5	1

Agricultural Working Group Summary

The Agricultural Working Group (AWG) consisted predominantly of beef and swine producers throughout the watershed. Representatives from organizations that serve this community and will have a role in implementation were also included (*e.g.*, PFSWCD, NRCS, and VADCR). The AWG is confident that current BMPs eligible for cost-share in TMDL areas and proposed recommendations will provide the necessary incentive for producers and horse owners to implement required BMPs to meet specified reductions to direct stream, pasture, and cropland bacteria loads. Challenges, recommendations, and keys for success discussed in the meetings included:

- ★ Primarily beef and swine operations exist in these watersheds. Attendees indicated there are sufficient waste storage facilities for the hog and poultry facilities. It was also noted that sufficient land was available for producers to spread collected waste and substantial exporting of manure and litter was not prevalent in these watersheds.
- ★ Constraints to BMP implementation indicated by group include – initial cost, land loss to buffer, and maintenance cost; there were no overriding cultural or contractor availability issues.
- ★ Applicable educational /outreach methods that work well in the area include: the joint PFSWCD, Farm Service Agency, and NRCS newsletter; field tours conducted by PFSWCD in spring and fall; educational events conducted by Virginia Cooperative Extension; Cattleman's Association events; information booth at Buckingham County Day; County Fair; and updates on the Chamber of Commerce website.
- ★ The PFSWCD has formed successful partnerships with James River Association and National Fish and Wildlife Foundation during past grant funded projects.
- ★ A typical 10-year implementation timeline was suggested for these watersheds with acknowledgment that water quality improvement may be observed much sooner in some of the watersheds. Due to varying levels of water quality observed in the impairments, staging implementation based on prioritizing impaired watersheds was suggested. Planning for BMP installations on larger farms, both technically and financially, can extend out several years.

- ★ Experience gained in the Willis River TMDL IP project showed implementation started fast, continued momentum in years two through four, and is slowing down in year five of the project.

Residential Working Group Summary

The Residential Working Group (RWG); consisting of watershed residents and VDH, PFSWCD, VADCR, VADEQ, and BRES personnel; focused on means to educate and involve public with regard to implementing corrective actions to replace straight pipes, correct failing septic systems, and manage pet waste. Challenges, recommendations, and keys for success discussed in the meeting included:

- ★ Septic tank pump-outs were referenced as a means to educate homeowners on how to maintain their septic systems and also provide an early warning of septic systems that may need a repair.
- ★ Seeking grant funds during implementation to supplement septic system pump-out cost not covered by cost-share was suggested.
- ★ A potential constraint to implementation is reluctance homeowner may have admitting a problem exists with on-site sewage disposal system because they do not want to get in trouble (with VDH).

Septic System Pump-out

- ★ VADCR has provided USEPA grant funds to remove straight pipes and repair or replace failing septic systems in areas where TMDL implementation projects are initiated following completion of the IP.
- ★ Pet waste composters will probably have limited application in the Slate River and Rock Island Creek watersheds due to larger lot sizes. Number of animals and type of disposal system for hunt clubs and dog kennels need to be identified and owners contacted to determine interest in participating in pilot project to install waste treatment systems.
- ★ The low impact development (LID) stormwater management BMPs and education program proposed at the new elementary school should be integrated with TMDL IP efforts.
- ★ Press releases identifying levels of cost-share available for fixing on-site sewage disposal systems problems should be made.

Governmental Working Group Summary

The Governmental Working Group (GWG) consisting of representatives from Buckingham County, PFSWCD, VADCR, VADEQ, VDH, NRCS, and BRES personnel, focused on funding sources, technical assistance needs, regulatory controls, and lead agencies responsible for implementation. Key topics and recommendations included:

- ★ Sufficient land exists to spread animal waste generated by operations in these watersheds.
- ★ CREP and EQIP programs have been popular in the past.

- The district anticipates continued installation of the Permanent Vegetative Cover on Cropland (SL-1), Reforestation of Erodible Crop and Pastureland (FR-1), and Woodland Buffer Filter Area (FR-3) practices in these watersheds.
- Significant landuse changes affecting bacteria loads in the watershed are not expected.
- Review of local ordinances and comprehensive plans to identify opportunities to promote water quality improvement; such as, implementation and/or preservation of riparian buffers or septic tank pump-out ordinance is needed.
- Field days, NRCS newsletter, County Fair, and Buckingham County Day are most significant outreach and educational methods used in the watersheds. Several events are joined by various organizations including: Buckingham County, PFSWCD, Farm Service Agency, NRCS, Virginia Cooperative Extension (VCE), and the Virginia Department of Forestry (VADOF).
- VADEQ is in the process of revising the monitoring strategy and will not have any specifics on monitoring stations – location and monitoring frequency. The new strategy may change any existing and/or tentative monitoring stations currently available. The only TMDL listing station tentatively scheduled for monitoring is in Rock Island Creek (2-RKI003.40), schedule to begin in 2015.
- Proposed roles and responsibilities for agencies included:
  - **Buckingham County:** administer the counties erosion and sediment control program and provide mapping assistance
  - **PFSWCD:** provide state agricultural cost-share funds, administer and provide technical assistance for agricultural and residential programs, and continue well-developed education program to successfully target both school-aged children and adults
  - **VADEQ:** provide ambient monitoring and assist with citizen monitoring
  - **NRCS, VDH,** and **VADOF**: provide technical assistance and funding

Steering Committee Summary

The Steering Committee consisted of representatives from the AWG, RWG, and GWG; Buckingham County; PFSWCD; VADCR; VADEQ; VDH; NRCS; and BRES. Steering Committee evaluated recommendations from working groups, reviewed BMP quantification and cost estimates, created implementation goals and milestones, reviewed monitoring plan, discussed potential funding resources available, revised implementation plan document, and evaluated materials for final public meeting. The Steering Committee will periodically revisit implementation progress and suggest plan revisions as needed.

IMPLEMENTATION ACTIONS

An assessment was conducted to quantify actions and cost for two implementation stages. Actions and cost that translate to an instantaneous standard exceedance rate of 10.5% or less, resulting in removal of these streams from the Commonwealth of Virginia's Section 303(d) List of Impaired Waters were quantified. This is referred to as the Stage I implementation goal. The Stage II implementation goal is TMDL source allocation attainment. Estimated units presented in Tables 2 and 3 depict the Stage I and Stage II goals. Potential control measures, their associated costs and efficiencies, and potential funding sources were identified through review of the TMDL, input from working groups, and literature review. Control measures were assessed based on cost, availability of existing funds, reasonable assurance of implementation, and water quality impacts. Measures that can be promoted through existing programs were identified, as well as those not currently supported by existing programs and their potential funding sources. The assurance of implementation of specific control measures was assessed through discussion with the working groups and Steering Committee.

The quantity of control measures, or BMPs, recommended during implementation was determined through spatial analyses and modeling alternative implementation scenarios. Spatial analyses of land use, stream-network, and the Commonwealth of Virginia aerial maps along with regionally appropriate data archived in the VADCR Agricultural BMP Database and TMDL document were utilized to establish average estimates of control measures to reduce bacteria loads in the watersheds. Additionally, input from local agency representatives, citizens, and contractors were used to verify the analyses.

Stream Exclusion Fencing

Agricultural Implementation Needs

Removing livestock from the stream corridor was identified as the primary control measure to reduce the livestock direct deposition bacteria load. There are approximately 712 miles of perennial streams in the Rock Island Creek and Slate River watersheds. Currently in these watersheds, approximately 22 miles of exclusion fencing have been installed through cost-share programs. Exclusion fencing necessary to prevent access to perennial streams and meet the stated TMDL reductions was estimated at approximately 259 miles of fence. Figure 3 displays analysis results for a portion of the watershed. This exclusion fencing is translated into a total of 406 exclusion systems to be installed to insure full exclusion of livestock from the streams. In order to provide implementation options to producers, several cost-share programs with varying goals and requirements were included. Based on historical cost-share program participation and working group feedback, total exclusion systems were divided between **Conservation Reserve and Enhancement Program (CREP), Environmental Quality Incentives Program (EQIP), Conservation Reserve Program (CRP), Livestock Exclusion with Riparian Buffers (LE-1T),**

Livestock Exclusion with Reduced Setback (LE-2T), Small Acreage Grazing System (SL-6AT), and Stream Protection (WP-2T) (Table 2). A typical LE-1T system includes streamside fencing, cross-fencing for pasture management, hardened crossing, alternative watering system, watering trough, water distribution piping, and a 35-ft buffer from the stream. In order to address pasture land reductions, the benefit of installing the livestock exclusion systems was coupled with improved pasture management BMPs. Total of 14,198 acres in the watersheds will be included in the **Pasture and Hayland Planting (NRCS Code 512), Pasture Management, and Prescribed Grazing (NRCS Code 528)** BMPs. Given reductions were not sufficient to meet TMDL reduction goals, installation of retention ponds may be necessary to treat runoff from this acreage during Stage II of implementation.

Bacteria reduction provided by four swine lagoons and three poultry litter sheds installed in the watersheds was accounted for in the land-applied loads. During IP development, the AWG noted a decreasing trend in cropland acres in the watersheds. Therefore, it was decided that the primary control measure for cropland bacteria load reduction will be permanent conversion of cropland to pasture and forest land uses. The conversion was divided between **SL-1 Permanent Vegetative Cover and FR-1 Reforestation of Erodible Crop and Pastureland BMPs** based on input from AWG and landuse difference. Additionally, **manure / biosolids incorporation** into soil was needed in the watersheds. Currently in these watersheds, approximately 117 cropland acres have been converted utilizing the SL-1 (41 acres) and FR-1 (76 acres) practices. Converting 21 acres to pasture and 30 acres to forest land uses and incorporating manure / biosolids into soil on approximately 949 cropland acres during Stage II satisfied the TMDL goal (Table 2).

Permanent Vegetative Cover on Cropland

Re-forestation

Table 2. Estimation of control measures with unit cost (average) needed to meet pasture and cropland bacteria load reduction implementation goals during 10-year timeline.

Control Measure	Unit	Unit Cost[1] ($)	Estimated Units Needed (#)							
			Rock Island Creek	Austin Creek	Frisby Creek	North River	Troublesome Creek	Upper Slate River	Lower Slate River	Total[2]
Pasture and Livestock Exclusion										
Livestock Exclusion System (CREP)	System	30,600	2	0	1	3	0	10	18	**34**
Livestock Exclusion System (EQIP and CBWI)	System	27,000	8	1	2	11	1	36	67	**126**
Livestock Exclusion System (CRP)	System	22,600	2	0	0	2	0	5	10	**19**
Livestock Exclusion System (LE-1T)	System	26,200	9	1	2	12	1	35	66	**126**
Livestock Exclusion System (SL-6AT)	System	22,600	0	0	0	0	0	1	2	**3**
Livestock Exclusion System (LE-2T)	System	16,000	7	0	0	8	2	23	44	**84**
Stream Protection System (WP-2T)	System	4,000	1	0	0	1	0	4	8	**14**
Improved Pasture Management[5]	Acres[3]	100	633	48	185	1,953	472	2,907	8,000	**14,198**
Retention Ponds	Acres[4]	2,000	85	0	45	799	271	439	2,720	**4,359**
Cropland										
Permanent Vegetative Cover on Cropland (SL-1)	Acres[3]	250	5	1	0	5	0	5	5	**21**
Reforestation of Erodible Crop and Pastureland (FR-1)	Acres[3]	450	15	0	0	5	0	5	5	**30**
Manure/Litter/Biosolids Incorporation into Soil	Acres[3]	25	60	12.5	0	24	42.5	230	580	**949**
Technical Assistance										
Agricultural – Pasture and Cropland	FTE	50,000/yr								**1 /yr**

[1] Unit cost = installation or one-time incentive payment, [2] Total for 10-year timeline, [3] Acres installed, [4] Acres treated, FTE = full time equivalent

[5]Improved pasture management comprised of Pasture and Hayland Planting (512), Pasture Management, and Prescribed Grazing (528) BMPs.

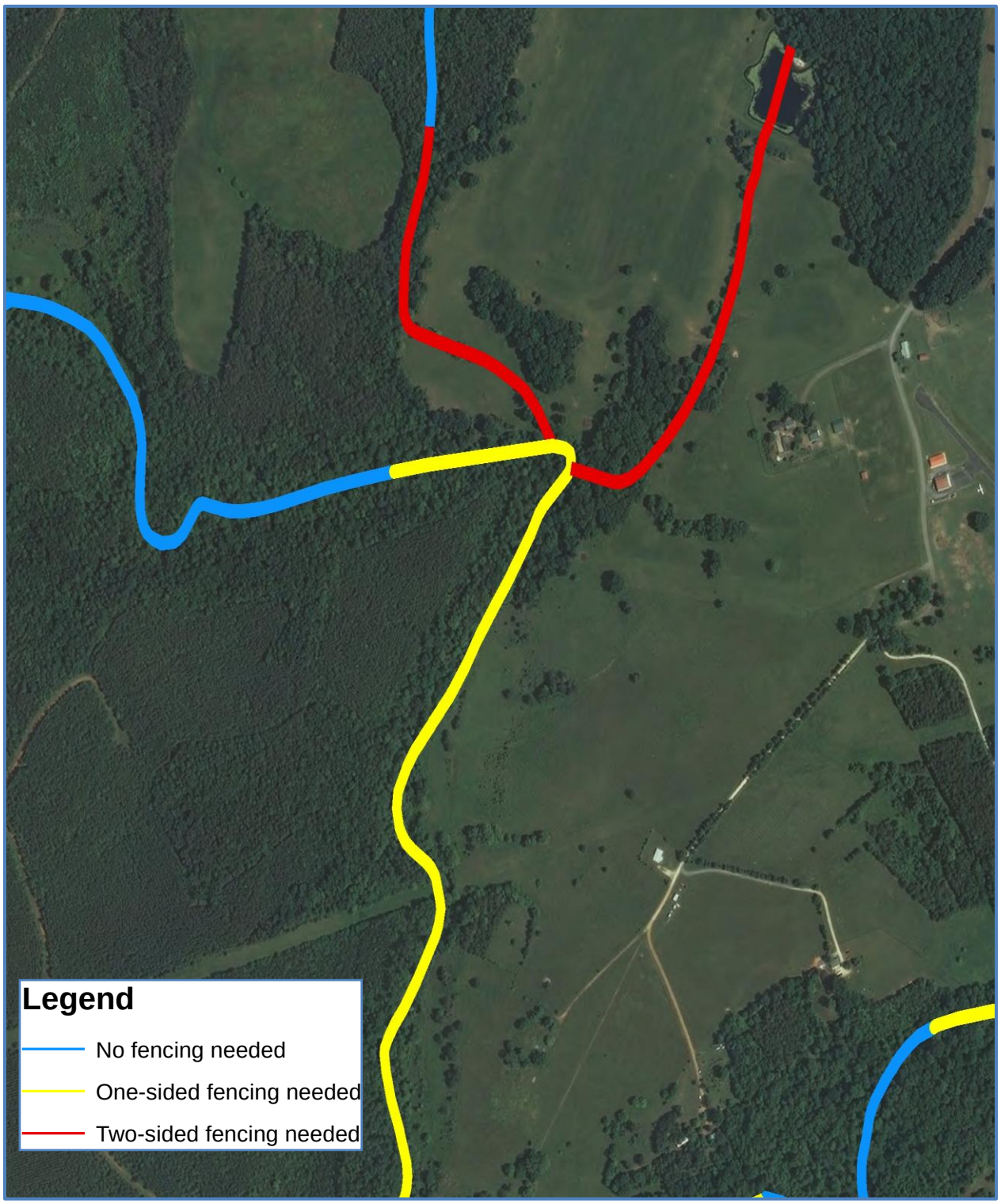


Figure 3. Potential livestock exclusion fencing analysis results for portion of Slate River.

Residential Implementation Needs

Septic System Repair

Based on discussion with Buckingham County Health Department and RWG, the number of straight pipes needing replacement is significantly less than number reported in TMDL document. During IP development, the number of failing septic systems was calculated using failure rates of 10%, 5%, and 1% for homes built prior to 1986, between 1986 and 2005, and after 2005, respectively. Based on discussion with Buckingham County Health Department and RWG, it was assumed that 90% of the straight pipes would be replaced with a conventional septic system and 10% replaced with an alternative on-site sewage disposal system (OSDS). Failing septic systems were assumed to be corrected by repairing the existing septic system (60%), installing a new conventional septic system (30%), or installing a new alternative OSDS (10%). It is estimated that 90 **septic system repairs**, 97 **septic systems**, and 20 **alternative OSDS** are considered necessary to correct straight pipes and failing septic systems during implementation (Table 3).

Pet Waste Composter

A four-step program was proposed to address pet waste reductions. In the first step, a **pet waste control program** consisting of educational packets, signage, and disposal stations in public areas will be instituted in each watershed. The second step will be installing **pet waste enzyme digesting composters** at 50 residences. The third step will be identification of confined canine units (CCU) and installing approximately four **CCU waste treatment systems** throughout the watersheds. The installation of **vegetated buffers**, **bioretention**, and **infiltration trenches** on residential land use is the fourth step. Components of the four-step program are outlined in Table 3.

Table 3. Estimation of control measures with unit cost (average) needed to meet residential and straight pipe bacteria load reduction implementation goals during 10-year timeline.

Control Measure	Unit	Unit Cost[1] ($)	Estimated Units Needed (#)							
			Rock Island Creek	Austin Creek	Frisby Creek	North River	Troublesome Creek	Upper Slate River	Lower Slate River	Total[2]
Residential										
Pet waste education program	Program	5,000								**1**
Pet waste digesters	System	50	10	0	0	0	0	15	25	**50**
Confined canine unit (CCU) Waste Treatment System	System	15,000	1	0	0	1	0	1	1	**4**
New Conventional Septic System	System	5,000	5	1	2	3	3	8	25	**47**
Alternative Sewage Disposal System	System	15,000	2	0	0	1	1	3	9	**16**
Septic System Repair	System	3,000	10	1	2	6	5	15	51	**90**
Vegetated Buffers	Acres[3]	400	2	1	1	2	0	4	10	**20**
Bioretention	Acres[4]	15,000	8	0	0	0	0	22	50	**80**
Infiltration Trench	Acres[4]	11,300	1	0	0	0	0	4	25	**30**
Straight Pipes										
New Conventional Septic System	System	5,000	4	1	1	4	4	8	28	**50**
Alternative Sewage Disposal System	System	15,000	0	0	0	0	0	1	3	**4**
Technical Assistance										
Urban	FTE	50,000/yr								**0.25 /yr**
On-site Sewage Disposal Systems	FTE	50,000/yr								**0.75 /yr**

[1] Unit cost = installation or one-time incentive payment, [2] Total for 10-year timeline, [3] Acres installed, [4] Acres treated, FTE = full time equivalent

Other Potential Implementation Needs

Implicit in the TMDL is the need to avoid increased delivery of pollutants from sources that have not been identified as needing a reduction, and from sources that may develop over time. Future residential development was identified as potential sources to deliver bacteria to streams through additional septic systems and pets. Care should be taken to monitor these activities and the impact on water quality. This needs to be carefully considered during permit issuance, site plans, and development.

Retention Pond

Assessment of Technical Assistance Needs

To determine the number of full time equivalents (FTE) considered necessary for agricultural technical assistance during implementation, the average cost-share amount of practices needed to be installed per year during implementation was divided by an average cost-share amount that one FTE can process in a year. Coupling the number of BMPs processed historically and estimates provided by PFSWCD and AWG, one FTE per year is needed throughout implementation (Table 2). Members of the GWG and Steering Committee estimated that one FTE per year would be required throughout implementation for OSDS corrections and pet waste management (Table 3).

Rotational Grazing System

Cost Analysis

Bioretention (Rain Garden)

Associated unit cost estimations for each implementation action during Stages I and II are shown in Tables 2 and 3. Table 4 lists installation and technical assistance costs to implement agricultural and residential programs for implementation Stages I and II. Focusing on Stage I (*i.e.*, removal of impairments from impaired waters list) costs, the total average installation cost for livestock exclusion systems and improved pasture management is $9.61 million. The total installation cost for converting cropland to permanent vegetative cover and forest is estimated at $0.02 million. Accordingly, total agricultural corrective action costs equal $9.63 million. Estimated corrective action costs needed to replace straight pipes and fix failing septic systems during Stage I totals $0.96 million. The cost to implement the first two steps of the pet waste reduction process totals an estimated eight thousand dollars.

It was determined by the PFSWCD, VADCR, AWG, RWG, GWG, and Steering Committee members that it would require $50,000 to support one technical FTE per year. The total costs to provide assistance in the agricultural and residential programs during Stage I implementation are both expected to be $0.30 million (Table 4). The total Stage I implementation cost including technical assistance is $11.19 million with the agricultural cost being $9.93 million and residential cost $1.26 million (Table 4).

Table 4. Implementation cost associated with percentage of practices to be installed along with technical assistance addressing agricultural and residential needs in the Rock Island Creek and Slate River watersheds.

Year	Agricultural				Residential				Total Cost
	Pasture & Livestock Access	Cropland	Technical Assistance	Total	On-site Sewage Disposal System	Pet Waste	Technical Assistance	Total	
	($)	($)	($)	($)	($)	($)	($)	($)	($)
1	915,900	0	50,000	965,900	74,000	5,000	50,000	129,000	1,094,900
2	1,810,100	4,400	50,000	1,864,500	143,000	600	50,000	193,600	2,058,100
3	1,901,500	4,400	50,000	1,955,900	203,000	600	50,000	253,600	2,209,500
4	1,936,500	4,700	50,000	1,991,200	203,000	600	50,000	253,600	2,244,800
5	1,924,500	4,700	50,000	1,979,200	193,000	600	50,000	243,600	2,222,800
6	1,119,900	0	50,000	1,169,900	140,000	600	50,000	190,600	1,360,500
7	110,500	100	50,000	160,600	3,000	400,600	50,000	453,600	614,200
8	97,300	100	50,000	147,400	5,000	402,400	50,000	457,400	604,800
9	147,300	12,000	50,000	209,300	42,000	402,800	50,000	494,800	704,100
10	8,821,500	12,000	50,000	8,883,500	49,000	402,800	50,000	501,800	9,385,300
Stage I Total (1-6)	**9,608,400**	**18,200**	**300,000**	**9,926,600**	**956,000**	**8,000**	**300,000**	**1,264,000**	**11,190,600**
Stage II Total (7-10)	**9,176,600**	**24,200**	**200,000**	**9,400,800**	**99,000**	**1,608,600**	**200,000**	**1,907,600**	**11,308,400**
Total (1-10)	**18,785,000**	**42,400**	**500,000**	**19,327,400**	**1,055,000**	**1,616,600**	**500,000**	**3,171,600**	**22,499,000**

Benefit Analysis

The primary benefit of implementation is cleaner waters in Virginia, where bacteria levels in the Slate River and Rock Island Creek impairments will be reduced to meet water quality standards. Actions during implementation can improve human and livestock herd health, benefit stakeholder economy, and improve the aquatic community.

Human Health

It is hard to gauge the impact that reducing fecal contamination will have on public health, as most cases of waterborne infection are not reported or are falsely attributed to other sources. However, the incidence of infection from fecal sources, through contact with surface waters, should be reduced considerably. The residential programs will play an important role in improving water quality, since human waste can carry with it human viruses in addition to the bacterial and protozoan pathogens that all fecal matter can potentially carry.

Livestock Herd Health

A clean water source coupled with exclusionary fencing has been shown to improve weight gain; decrease stress; reduce herd health risks associated with increased exposure to water-transmitted diseases, bacteria, virus and cysts infections; reduce mastitis and foot rot; and decrease herd injuries associated with cattle climbing unstable streambanks, or being stuck in mud.

Economics

An important objective of the IP is to foster continued economic vitality and strength. Healthy waters can improve economic opportunities for Virginians, and a healthy economic base can provide the resources and funding necessary to pursue restoration and enhancement activities. The agricultural and residential practices recommended in this document will provide economic benefits to the landowner, along with the expected environmental benefits on-site and downstream. For example, installing a livestock stream exclusion system with an alternative (clean) water source, improving pasture condition, performing sewage system maintenance, and improving aesthetics throughout the watershed can have an economic benefit on the local economy. Additionally, money spent by landowners, government agencies, and non-profit organizations in the process of implementing the IP will stimulate the local economy.

Vegetated Buffer (No Mow Zone)

The benefit of a Grazing Land Protection System BMP is improved profit through more efficient utilization and harvest of forage by grazing animals. Standing forage utilized directly by the grazing

animal is always less costly and of higher quality than the same forage harvested with equipment and fed to the animal (VCE, 1996). Several factors contribute to greater profitability: stocking rate can usually be increased by 30% to 50%; high-quality, fresh, and unsoiled vegetative growth available throughout the grazing system increases weight gain per acre; vigor of the pasture sod is improved; and handling and checking grazing animals is easier. More accurate estimates of the amount of forage available, greater uniformity in grazing of pastures, flexibility of harvesting and storing forage not needed for grazing, and extending the length of the grazing season while providing a more uniform quality and quantity of forage throughout the season are important benefits afforded by this system (VCE, 1996).

In terms of economic benefits to homeowners, an improved understanding of private OSDS, including knowledge of what steps can be taken to keep them functioning properly and the need for regular maintenance, will give homeowners the tools needed for extending the life of their systems and reducing the overall cost of ownership. In addition, investment in the home is protected with a properly functioning sewage disposal system. A home's value can be decreased up to 40% with a failed septic system (Shepherd, 2006). The average septic system will last 20-25 years if properly maintained. Proper maintenance includes: knowing the location of the system components and protecting them by not driving or parking on top of them, not planting trees where roots could damage the system, keeping hazardous chemicals out of the system, and pumping out the septic tank every three to five years. The cost of proper maintenance, as outlined here, is relatively inexpensive in comparison to repairing or replacing an entire system.

On-site Sewage Disposal System

Improved aesthetics in public areas (*e.g.*, parks) and surrounding businesses provided by control measures (*e.g.*, pet waste kiosks and bioretention) has the potential to draw local citizens and visitors to these areas. In addition, a healthy waterway has the potential to attract local citizens and visitors for recreation.

Aquatic Community Improved

Stream bank protection provided through exclusion of livestock including horses from streams will improve the aquatic habitat in these streams. Vegetated buffers that are established will also help reduce sediment and nutrient transport to the stream from upslope locations. The installation of improved pasture management systems should also reduce soil and nutrient losses and increase infiltration of precipitation; thereby, decreasing peak flows downstream. Reductions in nutrient and sediment loadings contribute to attainment of nutrient and sediment reduction goals for the Chesapeake Bay TMDL. Local initiatives, such as LID stormwater BMPs installed at new elementary school, will additionally be complemented by actions performed during TMDL implementation.

MEASUREABLE GOALS AND MILESTONES FOR ATTAINING WATER QUALITY STANDARDS

The end goals of implementation are:

1) Restored water quality in the impaired waters, and
2) Subsequent de-listing of streams from the Commonwealth of Virginia's Section 303(d) List of Impaired Waters.

Progress toward end goals will be assessed during implementation through tracking of control measure installations by Peter Francisco Soil and Water Conservation District; Natural Resources Conservation Service; Virginia Department of Conservation and Recreation; Virginia Department of Health; and Buckingham County. The Virginia Department of Environmental Quality will continue to assess water quality through its monitoring program. Other monitoring project activities in the watershed (*e.g.* citizen monitoring) will be coordinated to augment the Virginia Department of Environmental Quality monitoring program. Implementation will be assessed based on reducing exceedances of the bacteria water quality standard, thereby improving water quality.

Implementation of control measures is scheduled for 10 years and will be assessed in two stages beginning in January 2011 and lasting to December 2021. Stage I is based on meeting source allocations that translate to an instantaneous standard exceedance rate of 10.5% or less resulting in removal of streams from the Commonwealth of Virginia's Section 303(d) List of Impaired Waters. The Stage II goal is based on implementing source allocations to meet the specified TMDL goal, 0% exceedance of water quality standards. After implementation inception, five milestones will be met in two-year increments until streams are removed from Commonwealth of Virginia's Section 303(d) List of Impaired Waters. Monitoring data used in the 2010 impaired water assessment indicate a bacteria standard exceedance rate below 10.5% in Austin Creek, Frisby Branch, and Troublesome Creek. Strategy employed to address this potential improvement in water quality was to include control measure quantification for these watersheds and defer implementation of all control measures.

Streambank Buffer Establishment

Implementation in years one through six for agricultural source reductions focuses on installing livestock stream exclusion systems, improving pasture management, and cropland conversion (Table 5). BMPs installed in years seven through ten are based on additional treatment of bacteria load not treated during Stage I from pasture and cropland using improved pasture management, manure / biosolids incorporation into soil, and retention ponds (Table 5). Retention ponds are more costly and are logistically more difficult to design and locate on individual farms. Implementation in years one through six for residential bacteria loads focuses on identification and removal of straight pipes, repairing or replacing failed septic systems, instituting pet waste control program, installation of pet waste enzyme digesting composters, and installation of storage and treatment systems for waste from confined canine units (CCU) (Table 5). Implementation of these control measures will continue in years seven through ten if needed. Vegetated buffer, bioretention, and infiltration trench installations are expected to occur evenly over the last four years (Table 5).

Table 6 lists the cumulative progress towards the TMDL endpoint as implementation milestones are met. Water quality improvement is expected to increase each year. Based on water quality modeling projections for the sixth year, these streams would be in a probable position to be de-listed from the Commonwealth of Virginia's Section 303(d) List of Impaired Waters. Considering the dynamics of a stream ecosystem and the inherent difficulties that may arise preventing implementation, the final milestone of TMDL allocation attainment was set at 10 years following implementation commencement.

The process of a staged implementation implies targeting of control measures, ensuring optimum utilization of resources. In quantifying agricultural BMPs through the use of aerial photography, land use, and stream network GIS layers, maps were formulated showing potential livestock stream access, pastures, and crop fields. Known problem areas, clusters of older homes, or houses in close proximity to streams known by the VDH will be targeted for onsite treatment system control measures. Steps outlined in pet waste BMP stages results in targeting of source type and resources. Significant exposure to a rain garden and/or infiltration trench project would be attained if installed at the new elementary school. Buckingham County High School was also identified as a potential project location.

Table 5. Targeted implementation stages for control measures installation.

Control Measure	Rock Island Creek	Austin Creek	Frisby Creek	North River	Troublesome Creek	Upper Slate River	Lower Slate River
Pasture and Livestock Exclusion							
Livestock Exclusion System (CREP)	I	II	II	I	II	I	I
Livestock Exclusion System (EQIP)	I	II	II	I	II	I	I
Livestock Exclusion System (CRP)	I	II	II	I	II	I	I
Livestock Exclusion System (LE-1T)	I	II	II	I	II	I	I
Livestock Exclusion System (SL-6AT)	I	II	II	I	II	I	I
Livestock Exclusion System (LE-2T)	I	II	II	I	II	I	I
Stream Protection System (WP-2T)	I	II	II	I	II	I	I
Improved Pasture Management	I & II	II	II	I & II	II	I & II	I & II
Retention Ponds	II	II	II	II	II	II	II
Cropland							
Permanent Vegetative Cover on Cropland (SL-1)	I	II	II	I	II	I	I
Reforestation of Erodible Crop and Pastureland (FR-1)	I	II	II	I	II	I	I
Manure / Litter / Biosolids Incorporation into Soil	II	II	II	II	II	II	II
Residential and Straight Pipes							
Pet waste education program	I	II	II	I	II	I	I
Pet waste digesters	I	II	II	I	II	I	I
Confined Canine Unit (CCU) Waste Treatment System	II	II	II	II	II	II	II
Septic System Repair	I	II	II	I	II	I	I
New Conventional Septic System	I	II	II	I	II	I	I
Alternative Sewage Disposal System	I	II	II	I	II	I	I
Vegetated Buffers	II	II	II	II	II	II	II
Bioretention	II	II	II	II	II	II	II
Infiltration Trench	II	II	II	II	II	II	II

Stage I = first six years of implementation for a 10-year timeline

Stage II = last four years of implementation for a 10-year timeline

Table 6. Cumulative implementation of control measures and water quality milestones.

Control Measure	Unit	Progress Since TMDL Study	Milestone 1 Completed by Jan. 2013	Milestone 2 Completed by Jan. 2015	Milestone 3 Completed by Jan. 2017	Milestone 4 Completed by June 2019	Milestone 5 Completed by June 2021
Pasture							
Livestock Exclusion System (CREP)	System	34	9	24	33	34	34
Livestock Exclusion System (EQIP)	System	0	36	83	122	124	126
Livestock Exclusion System (CRP)	System	0	4	12	19	19	19
Livestock Exclusion System (LE-1T)	System	0	36	84	122	123	126
Livestock Exclusion System (SL-6AT)	System	0	0	1	3	3	3
Livestock Exclusion System (LE-2T)	System	0	22	56	82	83	84
Stream Protection System (WP-2T)	System	0	3	9	14	14	14
Improved Pasture Management	Acres - Installed	N/A	2,696	5,393	8,091	10,791	14,198
Retention Pond	Acres - Treated	N/A	0	0	0	0	4,359
Cropland							
Permanent Vegetative Cover on Cropland (SL-1)	Acres - Installed	41	5	15	20	20	21
Reforestation of Erodible Crop and Pastureland (FR-1)	Acres - Installed	76	7	22	30	30	30
Manure / Biosolids Incorporation into Soil	Acres - Treated	0	0	0	0	0	949
Residential							
Pet waste education program	System	N/A	1	1	1	1	1
Pet waste digesters	System	N/A	10	30	50	50	50
Confined Canine Unit Waste Treatment System	System	N/A	0	0	0	2	4
New Conventional Septic System	System	N/A	23	58	85	86	97
Alternative Sewage Disposal System	System	N/A	2	11	19	19	20
Septic System Repair	System	N/A	24	56	82	83	90
Vegetated Buffers	Acres - Installed	N/A	0	0	0	10	20
Bioretention	Acres - Treated	N/A	0	0	0	40	80
Infiltration Trench	Acres - Treated	N/A	0	0	0	15	30

Impairment	**Instantaneous Bacteria Standard Exceedance Rate (%)**					
	Existing	**Stage 1**	**Stage 2**	**Stage 3**	**Stage 4**	**Stage 5**
Frisby Branch	8	N/A	N/A	N/A	N/A	N/A
Austin Creek	0	N/A	N/A	N/A	N/A	N/A
Troublesome Creek	4	N/A	N/A	N/A	N/A	N/A
Rock Island Creek	22	17	12	8	8	6
North River	20	18	17	15	14	2
Upper Slate River	21	18	15	13	12	2
Lower Slate River	19	14	12	10	9	2
Cumulative Implementation Cost (millions $)	**N/A**	**3.1**	**7.6**	**11.2**	**12.4**	**22.5**

Water Quality Monitoring

Implementation progress will be evaluated through water quality monitoring conducted by VADEQ through the agency's monitoring program and any additional monitoring support (*i.e.*, citizen monitoring) that may develop as implementation progresses. Ten ambient VADEQ monitoring stations were utilized to assess water quality in the Rock Island Creek and Slate River watersheds (Table 7 and Figure 4). Station 2-SLT003.68 on the Slate River is classified as a "trend station". Trend stations are historically located, long-term water quality monitoring stations used to assess changes in water quality over long periods of time and are sampled at least six times per year. The remaining stations are classified as "watershed stations". Watershed stations are typically located near mouth of a watershed, designed to provide comprehensive statewide coverage of smaller watersheds, and sampled 12 times over a consecutive two-year period (sampling occurs every other month) within a six-year rotational cycle.

The citizen monitoring program can be utilized to supplement samples collected through VADEQ's ambient monitoring program. The Coliscan Easygel method is a simple to use and relatively inexpensive method that measures total coliform and *E. coli*. The Coliscan Easygel method was compared to laboratory analysis and found to be an acceptable tool for screening purposes although the data cannot be used directly by VADEQ for water quality assessments. This method is important because it can assist in locating "hot spots" for fecal contamination, assess implementation progress, and target areas for more extensive monitoring. James River Association performs monitoring in the James River watershed and could potentially supplement monitoring for Rock Island Creek and Slate River.

The AWG, RWG, GWG, and Steering Committee request that monitoring continue at the TMDL impairment listing station for the following parameters: *E. coli* bacteria, temperature, dissolved oxygen, pH, specific conductance, total nitrogen, total phosphorus, total suspended solids, and stream flow.

Table7. Impairment, monitoring station identification, station type, and monitoring schedule for VADEQ monitoring stations in these watersheds.

Impairment	Station ID	Station Type	Monitoring Schedule
Rock Island Creek	2-RKI003.40	Watershed	Bimonthly, 2013 – 2014
Austin Creek	2-AUS001.12	Watershed	Program Dependent
Frisby Branch	2-FRY000.35	Watershed	Program Dependent
	2-FRY003.00	Watershed	Program Dependent
North River	2-NTH001.65	Watershed	Program Dependent
	2-NTH003.88	Watershed	Bimonthly, 2013 – 2014
Troublesome Creek	2-TBM000.80	Watershed	Program Dependent
Upper Slate River	2-SLT024.72	Watershed	Program Dependent
	2-SLT030.19	Watershed	Program Dependent
Lower Slate River	2-SLT003.68	Trend	Bimonthly, long-term
	2-SLT014.52	Watershed	Bimonthly, 2015 – 2016
	2-SLT018.85	Watershed	Bimonthly, 2015 – 2016

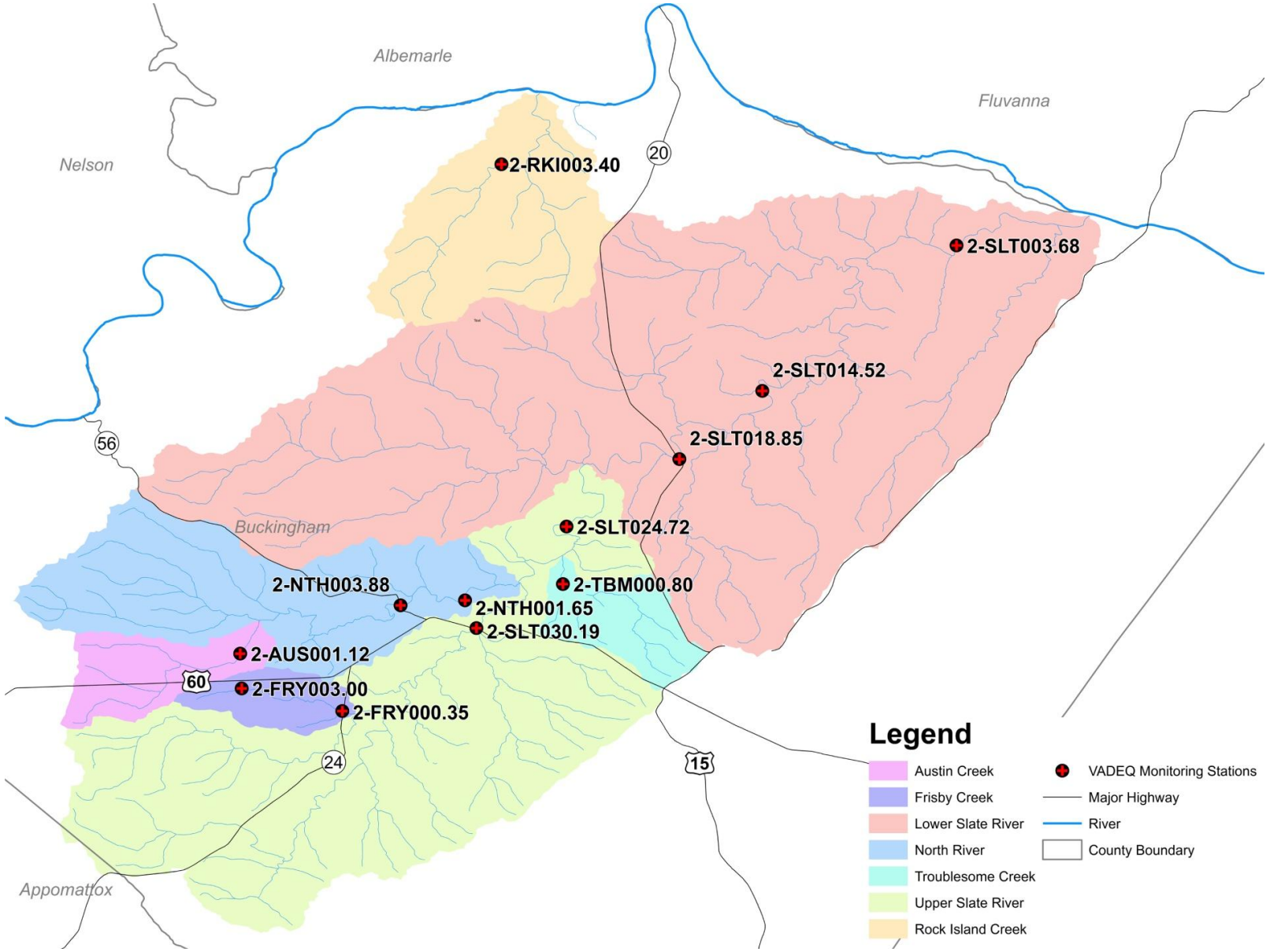


Figure 4. Location of VADEQ monitoring stations in the Rock Island Creek and Slate River watersheds.

STAKEHOLDER'S ROLES & RESPONSIBILITIES

Stakeholders are individuals who live or have land management responsibilities in the watershed, including government agencies, businesses, private individuals, and special interest groups. Successful implementation depends on stakeholders taking responsibility for their role in the process. The primary role falls on the local groups that are most affected; that is, businesses, community watershed groups, and citizens. However, local, state, and federal agencies also have a stake in seeing that Virginia's waters are clean and provide a healthy environment for its citizens.

Alternative Water Source

Regional and local government groups work closely with state and federal agencies throughout the TMDL process; these groups possess insights about their community that may help to ensure the success of TMDL implementation. These stakeholders have knowledge about a community's priorities, how decisions are made locally, and how the watershed's residents interact. Buckingham County and Peter Francisco Soil and Water Conservation District (PFSWCD) will have prominent roles during implementation. PFSWCD will provide state agricultural cost-share funds, lead education and technical assistance efforts, and track best management practice implementation for the agricultural and residential programs. The district has a well-developed education program successfully targeting school-aged children and adults.

In the Commonwealth of Virginia, water quality problems are dealt with through legislation, incentive programs, education, and legal actions. State government has the authority to establish state laws that control delivery of pollutants to local waters. Local governments in conjunction with the state can develop ordinances involving pollution prevention measures. State agencies conducting regulatory, education, or funding procedures related to water quality in Virginia include: Virginia Department of Environmental Quality (VADEQ); Virginia Department of Conservation and Recreation (VADCR); Virginia Department of Health (VDH); Virginia Department of Agriculture and Consumer Services (VADACS); Virginia Department of Game and Inland Fisheries (VDGIF); Virginia Department of Forestry (VADOF); and Virginia Cooperative Extension (VCE).

The roles and responsibilities of some of the major stakeholders on a local, state, and federal level are as follows:

Buckingham County Government Departments: Government staff work closely with local and state agencies to develop and implement the TMDL. Staff will administer the erosion & sediment control and stormwater programs, provide mapping assistance, and may also help to promote education and outreach to citizens, businesses, and developers to introduce the importance of the TMDL process.

PFSWCD: The Peter Francisco Soil and Water Conservation District is a local unit of government responsible for the soil and water conservation work within Buckingham and Cumberland Counties. The district's overall role is to increase voluntary conservation practices among farmers, ranchers, and other land users. District staff work closely with watershed residents and have valuable knowledge of local watershed practices. Specific to the IP, the district will provide agricultural cost-share funds, lead education and technical assistance efforts, and track best management practice implementation for the agricultural and residential programs.

Citizens & Businesses: The primary role of citizens and businesses is simply to get involved in implementation. This may include participating in public outreach, implementing BMPs to help restore water quality, and partnering with other stakeholders to improve water quality.

Alternative On-site Sewage Disposal System

Community Civic Groups: Community civic groups take on a wide range of community service including environmental projects. Such groups include the Ruritan, Farm Clubs, Homeowner Associations and youth organizations such as 4-H and Future Farmers of America. These groups offer a resource to assist in the public participation process, educational outreach, and assisting with implementation activities in local watersheds.

Animal Clubs/Associations: Clubs and associations for various animal groups (*e.g.*, beef, equine, poultry, swine, and canine) provide a resource to assist and promote conservation practices among farmers and other landowners, not only in rural areas, but in residential areas as well.

Middle James River Roundtable: The Roundtable is a collaborative effort among various stakeholders in the Middle James watershed to improve water quality and the overall health of our communities. Roundtable stakeholders include elected officials, local government staff, the agricultural community, planning district commissions, business and industry, water and sewer utilities, commercial fishermen, soil and water conservation districts, developers, interested citizens, environmental groups, tourism and recreational groups, state and federal agency staff and public service authorities. Roundtable activities are dictated by the participants and can involve activities such as hosting forums to discuss local watershed issues and land use, educating citizens about water quality, grant writing, coordinating workshops, social marketing campaigns, collecting and analyzing water quality data and planning and implementation of watershed goals.

James River Association: The mission of the James River Association is to be guardian of the James River. The Association provides a voice for the river and takes action to promote conservation and responsible stewardship of its natural resources. Goals are achieved through four core programs: Watershed Restoration; Education and Outreach; River Advocacy; and River Keeper.

VADEQ: The State Water Control Law authorizes the SWCB to control and plan for the reduction of pollutants impacting the chemical and biological quality of the State's waters resulting in the degradation of the recreation, fishing, shellfishing, aquatic life, and drinking water uses. For many years the focus of VADEQ's pollution reduction efforts was the treated effluent discharged into Virginia's waters via the VPDES permit process. The TMDL process has expanded the focus of VADEQ's pollution reduction efforts from the effluent of wastewater treatment plants to the pollutants causing impairments of the streams, lakes, and estuaries. The reduction tools are being expanded beyond the permit process to include a variety of voluntary strategies and BMPs. VADEQ is the lead agency in the TMDL process. The Code of Virginia directs VADEQ to develop a list of impaired waters, develop TMDLs for these waters, and develop IPs for the TMDLs. VADEQ administers the TMDL process, including the public participation component, and formally submits the TMDLs to USEPA and the SWCB for approval. VADEQ is also responsible for implementing point source WLAs, regulation of biosolids applications, assessing water quality across the state, and conducting water quality standard related actions.

VADCR: The Virginia Department of Conservation and Recreation is authorized to administer Virginia's NPS pollution reduction programs in accordance with §10.1-104.1 of the Code of Virginia and §319 of the Clean Water Act. Because of the magnitude of the NPS component in the TMDL process, VADCR is a major participant in the TMDL process. VADCR has a lead role in the development of IPs to address correction of NPS pollution contributing to water quality impairments. VADCR also provides available funding and technical support for the implementation of NPS components of IPs. The staff resources in VADCR's TMDL program focus primarily on providing technical assistance and funding to stakeholders to develop and carry out IPs, and support to VADEQ in TMDL development related to NPS impacts. Under the Virginia Stormwater Management Program, VADCR is responsible for the issuance, denial, revocation, termination, and enforcement of National Pollutant Discharge Elimination System (NPDES) permits for the control of stormwater discharges from municipal separate storm sewer systems (MS4) and land disturbing activities. VADCR staff will be working with other state agencies, local governments, soil and water conservation districts, watershed groups, and citizens to gather support and to improve the implementation of TMDL plans through utilization of existing authorities and resources.

VDH: The Virginia Department of Health is responsible for maintaining safe drinking water measured by standards set by the USEPA. Their duties also include septic system regulation, driven by complaints. Complaints can range from a vent pipe odor that is not an actual sewage violation and takes very little time to investigate, to a large discharge violation that may take many weeks or longer to effect compliance. For TMDLs, VDH has the responsibility of enforcing actions to correct failed septic systems and/or eliminate straight pipes (Sewage Handling and Disposal Regulations, 12 VAC 5-610-10 *et seq*.).

VADACS: The Virginia Department of Agriculture and Consumer Services Commissioner of Agriculture has the authority to investigate claims that an agricultural producer is causing a water quality problem on a case-by-case basis (Pugh, 2001). If deemed a problem, the Commissioner can order the producer to

submit an agricultural stewardship plan to the local soil and water conservation district. If a producer fails to implement the plan, corrective action can be taken, which may include civil penalties. The Commissioner of Agriculture can issue an emergency corrective action if runoff is likely to endanger public health, animals, fish and aquatic life, public water supply, *etc*. An emergency order can shut down all or part of an agricultural activity and require specific stewardship measures.

VDGIF: The Virginia Department of Game and Inland Fisheries manages Virginia's wildlife and inland fish to maintain optimum populations of all species to serve the needs of the Commonwealth; provides opportunity for all to enjoy wildlife, inland fish, boating and related outdoor recreation; and promotes safety for persons and property in connection with boating, hunting, and fishing. The VDGIF has responsibility for administering certain U.S. Fish and Wildlife Service funding programs. Personnel participate, review, and comment on projects processed through state and federal project and permitting review processes to insure the consideration for fish and wildlife populations and associated habitats.

VADOF: The VADOF has prepared a manual to inform and educate forest landowners and the professional forest community on proper BMPs and technical specifications for installation of these practices in forested areas (www.dof.state.va.us/wq/wq-bmp-guide.htm). Forestry BMPs are intended to primarily control erosion. For example, streamside forest buffers provide nutrient uptake and soil stabilization, which can benefit water quality by reducing the amount of nutrients and sediments that enter local streams.

Riparian Forest Buffer

VCE: Virginia Cooperative Extension is an educational outreach program of Virginia's land grant universities (Virginia Tech and Virginia State University), and a part of the national Cooperative State Research, Education, and Extension Service, an agency of the United States Department of Agriculture (USDA). VCE is a product of cooperation among local, state, and federal governments in partnership with citizens. VCE offers educational programs and technical resources for topics such as crops, grains, livestock, poultry, dairy, natural resources, and environmental management. VCE has published several publications that deal specifically with TMDLs. For more information on these publications and to find the location of county extension offices, visit www.ext.vt.edu.

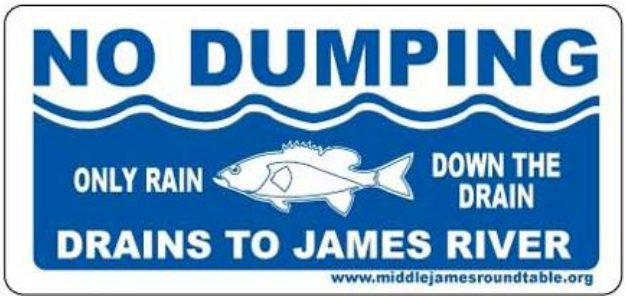
USEPA: The United States Environmental Protection Agency has the responsibility of overseeing the various programs necessary for the success of the CWA. However, administration and enforcement of such programs falls largely to the states. USEPA provides funding to implement TMDLs through Section 319 Incremental Funds.

NRCS: The Natural Resources Conservation Service is the federal agency that works hand-in-hand with the American people to conserve natural resources on private lands. NRCS assists private landowners with conserving their soil, water, and other natural resources. Local, state and federal agencies along with policymakers also rely on the expertise of NRCS staff. NRCS is a major funding stakeholder for impaired water bodies through the CREP and EQIP programs.

INTEGRATION WITH OTHER WATERSHED PLANS

Each watershed within the state is under the jurisdiction of a multitude of individual yet related water quality programs and activities, many of which have specific geographical boundaries and goals. These include but are not limited to Chesapeake Bay 2000 agreement, Tributary Nutrient Reduction Plans, TMDLs, Roundtables, Water Quality Management Plans, Erosion and Sediment Control Regulations, Stormwater Management Program, Source Water Assessment Program, and local comprehensive plans. The progress of these planning efforts needs continuous evaluation to determine possible effects on implementation goals. For example, financial and technical resources may be maximized for implementation by coordinating and expanding the planning and implementation activities of these on-going watershed activities. Current initiatives within Buckingham County to be integrated with the Slate River and Rock Island Creek TMDL IP include:

- Buckingham County Comprehensive Plan
- Middle James Roundtable Strategic Plan
- James River Association Strategic Plan
- Willis River TMDL IP
- Chesapeake Bay Watershed Improvement Plan
- Virginia Wildlife Action Plan



Middle James Roundtable Storm Drain Markers

Chesapeake Bay Watershed Improvement Plan

POTENTIAL FUNDING SOURCES

Potential funding sources available during implementation were identified in the course of plan development. Detailed description of each source (*i.e.*, eligibility requirements, specifications, incentive payments) can be obtained from the PFSWCD, VADCR, VADEQ, VADGIF, VCE, VDH, and NRCS. Table 8 illustrates various financial opportunities that exist from selected cost-share programs for agricultural and residential implementation needs. Sources include:

- Federal Clean Water Act Section 319 Incremental Funds
- U.S. Department of Agriculture (USDA) Conservation Reserve Enhancement Program (CREP)
- USDA Conservation Reserve Program (CRP)
- USDA Environmental Quality Incentives Program (EQIP)
- USDA Chesapeake Bay Watershed Initiative (CBWI)
- USDA Forest Incentive Program (FIP)
- USDA Wetland Reserve Program (WRP)
- USDA Wildlife Habitat Incentive Program (WHIP)
- U.S. Fish and Wildlife Service Conservation Grants
- U.S. Fish and Wildlife Service Private Stewardship Program
- Virginia Agricultural Best Management Practices Cost-Share Program
- Virginia Agricultural Best Management Practices Tax Credit Program
- Virginia Water Quality Improvement Fund
- Virginia Landowner Incentive Program
- Virginia Forest Stewardship Program
- Virginia Small Business Environmental Compliance Assistance Fund
- Virginia Clean Water Revolving Loan Fund (VCWRLF)
- Community Development Block Grant Program
- Southeast Rural Community Assistance Project (Southeast RCAP)
- National Fish and Wildlife Foundation
- Chesapeake Bay Foundation

Table 8. Control measures with estimated cost-share program and landowner costs.

Control Measure	Program Code	Unit	Cost-share	Average Cost/Unit to State or Federal Program ($)	Average Cost/Unit to Landowner ($)[1]
Livestock exclusion with 35 ft buffer	CREP	System	90% + varied incentive	27,540	3,060[A]
	EQIP	System	75%	20,250	6,750
	LE-1T	System	85%	22,270	3,930
Livestock exclusion with 20 ft buffer	CRP	System	75%	16,950	5,650
Horse exclusion with 35 ft setback	SL-6AT	System	50%	11,300	11,300
Livestock exclusion with 10 ft setback	LE-2T	System	50%	8,000	8,000
Stream Protection	WP-2T	System	75% + $0.50/ft incentive	3,500	500
Pasture and Hayland Re-planting	512	Acres	$165/ac	165	40
Prescribed grazing	528	Acres	$30/ac	30	30
Permanent vegetative cover on cropland	SL-1	Acres	75% + $30/ac incentive	240	33
Reforestation of erodible crop and pastureland	FR-1	Acres	75% + $300/ac	450	150
Manure / biosolids soil incorporation	N/A	Acres	N/A	0	25
Septic tank pump-out	RB-1	System	50%	150	150
Septic Tank System Repair	RB-3	System	50% - 75%	1,500 – 2,250	750 - 1,500
Septic Tank System Installation / Replacement	RB-4	System	50% - 75%	2,500 – 3,750	1,250 - 2,500
Septic Tank System Installation / Replacement w/ Pump	RB-4P	System	50% - 75%	5,000 – 7,500	2,500 - 5,000
Alternative On-site Waste Treatment System	RB-5	System	50% - 75%	7,500 – 11,250	3,750 - 7,500

[1] Does not include tax credit or in-kind service; [A] Value does not reflect incentive payment

LIST OF ACRONYMS

AWG	Agricultural Working Group
BMP	Best Management Practice
CCU	Confined Canine Unit
CREP	Conservation Reserve and Enhancement Program
CRP	Conservation Reserve Program
CWA	Clean Water Act
EQIP	Environmental Quality Incentive Program
FR-1	Reforestation of Erodible Crop and Pastureland
FSA	Farm Service Agency
FTE	Full Time Equivalent
GWG	Government Working Group
IP	Implementation Plan
LE-1T	Livestock Exclusion with Riparian Buffers
LE-2T	Livestock Exclusion with Reduced Setback
LID	Low Impact Development
NLCD	National Land Cover Dataset
NPS	Nonpoint Source
NRCS	Natural Resources Conservation Service
NWBD	National Watershed Boundary Dataset
OSDS	On-Site Sewage Disposal System
PFSWCD	Peter Francisco Soil and Water Conservation District
RB-1	Septic System Pump-Out
RB-2	Connection of Malfunctioning OSSDS or Straight Pipe to Public Sewer
RB-3	Septic Tank System Repair
RB-4	Septic Tank Installation / Replacement
RB-5	Alternative On-Site Waste Treatment System
RCAP	Rural Community Assistance Program
RWG	Residential Working Group
SL-1	Permanent Vegetative Cover on Cropland
SL-6	Grazing Land Protection System
SWCB	State Water Control Board
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
VADACS	Virginia Department of Agriculture and Consumer Services
VADCR	Virginia Department of Conservation and Recreation
VADEQ	Virginia Department of Environmental Quality
VADOF	Virginia Department of Forestry
VCE	Virginia Cooperative Extension
VDGIF	Virginia Department of Game and Inland Fisheries
VDH	Virginia Department of Health
WP-2T	Stream Protection
WQIF	Water Quality Improvement Fund
WQMIRA	Water Quality Monitoring, Information and Restoration Act
WHIP	Wildlife Habitat Incentive Program
WRP	Wetland Reserve Program

GLOSSARY

Anthropogenic - involving the impact of humans on nature; specifically items or actions induced, caused, or altered by the presence and activities of humans.

Assimilative Capacity - a measure of the ability of a natural body of water to effectively degrade and/or disperse chemical substances. Assimilative capacity is used to define the ability of a waterbody to naturally assimilate a substance without impairing water quality or degrading the aquatic ecosystem. Numerically, it is the amount of pollutant that can be discharged to a specific waterbody without exceeding water quality standards. (see Loading Capacity)

Bacterial Source Tracking (BST) - A collection of scientific methods used to track sources of fecal coliform.

Benthic – refers to material, especially sediment, at the bottom of a waterbody. It can used to describe the organisms that live on, or in, the bottom of a waterbody.

Best Management Practices (BMPs) - reasonable and cost-effective means to reduce the likelihood of pollutants entering a water body. BMPs include riparian buffer strips, filter strips, nutrient management plans, conservation tillage, etc.

Cost-share Program - a program that allocates funds to pay a percentage of the cost of constructing or implementing a BMP. The remaining costs are paid by the producer(s).

Delisting - the process by which an impaired waterbody is removed from the Section 303(d) Impaired Waters List. To remove a waterbody from the Section 303(d) list, the state must demonstrate to USEPA, using monitoring or other data, that the waterbody is attaining the water quality standard.

Die-off (of fecal coliform) - Reduction in the fecal coliform population due to predation by other bacteria as well as by adverse environmental conditions (e.g., UV radiation, pH).

Discharge - flow of surface water in a stream or canal or the outflow of groundwater from a flowing artesian well, ditch or spring; can also apply to discharge of liquid effluent from a facility or to chemical emissions into the air through designated venting systems.

Erosion - detachment and transport of soil particles by water and wind. Sediment resulting from soil erosion represents the single largest source of nonpoint source pollution in the United States.

Failing septic system - Septic systems in which drain fields have failed such that effluent (wastewater) that is supposed to percolate into the soil, now rises to the surface and ponds on the surface where it can flow over the soil surface to streams or contribute pollutants to the surface where they can be lost during storm runoff events.

Fecal coliform - A type of bacteria found in the feces of various warm-blooded animals that is used as indicator of the possible presence of pathogenic (disease causing) organisms.

Full Time Equivalent (FTE) - Is a way to estimate staff needed for a project. A FTE of 1.0 means that the position is equivalent to a full-time worker, while a FTE of 0.5 indicates a part-time worker.

Geographic Information System (GIS) - a system of hardware, software, data, people, organizations and institutional arrangements for collecting, storing, analyzing and disseminating information about areas of the earth. An example of a GIS is the use of spatial data for Emergency Services response (E-911). Dispatchers use GIS to locate the caller's house, identify the closest responder, and even determine the shortest route. All these activities are automated using the electronic spatial data in the GIS.

Geometric mean - The geometric mean is simply the nth root of the product of n values. Using the geometric mean lessens the significance of a few extreme values (extremely high or low values). In practical terms, this means that if you have just a few bad samples, their weight is lessened.

Mathematically the geometric mean, $\overline{x}_g$, is expressed as: $\overline{x}_g = \sqrt[n]{x_1 \cdot x_2 \cdot x_3 \ldots \cdot x_n}$ where n is the number of samples, and xi is the value of sample i.

HSPF (Hydrological Simulation Program-Fortran) - A computer-based model that calculates runoff, sediment yield, and fate and transport of various pollutants to the stream. The model was developed under the direction of the U.S. Environmental Protection Agency (EPA).

Impaired waters - those waters with chronic or recurring monitored violations of the applicable numeric and/or narrative water quality standards.

Instantaneous criterion - The instantaneous criterion or instantaneous water quality standard is the value of the water quality standard that should not be exceeded at any time. For example, the Virginia instantaneous water quality standard for E.coli is 235 cfu/100 mL. If this value is exceeded at any time, the water body is in exceedance of the state water quality standard.

Load allocation (LA) - portion of the loading capacity attributed to 1) the existing or future nonpoint sources of pollution, and 2) natural background sources. Wherever possible, nonpoint source loads and natural loads should be distinguished.

Margin of safety (MOS) - a required component of the TMDL that accounts for the uncertainty in calculations of pollutant loading from point, nonpoint, and background sources.

Modeling - a system of mathematical expressions that describe both hydrologic and water quality processes. When used for the development of TMDLs, models can estimate the load of a specific pollutant to a waterbody and make predictions about how the load would change as remediation steps are implemented.

Monitoring - periodic or continuous sampling and measurement to determine the physical, chemical, and biological status of a particular media like air, soil, or water.

Nonpoint source pollution - pollution originating from multiple sources on and above the land. Examples include runoff from fields, stormwater runoff from urban landscapes, roadbed erosion in forestry, and atmospheric deposition.

Nutrient - any substance assimilated by living things that promotes growth. The term is generally applied to nitrogen and phosphorus in wastewater, but is also applied to other essential and trace elements.

Pathogen - Disease-causing agent, especially microorganisms such as certain bacteria, protozoa, and viruses.

Point source pollution - pollutant loads discharged at a specific location from pipes, outfalls, and conveyance channels from either municipal wastewater treatment plants or industrial treatment facilities or any conveyance such as a ditch, tunnel, conduit or pipe from which pollutants are discharged. Point sources have a single point of entry with a direct path to a water body. Point sources can also include pollutant loads contributed by tributaries to the main receiving stream or river.

Riparian - pertaining to the banks of a river, stream, pond, lake, etc., as well as to the plant and animal communities along such bodies of water

Runoff - that part of precipitation, snowmelt, or irrigation water that does not infiltrate but flows over the land surface, eventually making its way to a stream, river, lake or an ocean. It can carry pollutants from the land and air into receiving waters.

Sediment - in the context of water quality, soil particles, sand, and minerals dislodged from the land and deposited into aquatic systems as a result of erosion.

Septic system - An on-site system designed to treat and dispose of domestic sewage. A typical septic system consists of a tank that receives liquid and solid wastes from a residence or business and a drainfield or subsurface absorption system consisting of a series of tile or percolation lines for disposal of the liquid effluent. Solids (sludge) that remain after decomposition by bacteria in the tank must be pumped out periodically.

Simulation - The use of mathematical models to approximate the observed behavior of a natural water system in response to a specific known set of input and forcing conditions. Models that have been validated, or verified, are then used to predict the response of a natural water system to changes in the input or forcing conditions.

Stakeholder - any person or organization with a vested interest in development and implementation of a local watershed water quality implementation plan (e.g., farmer, landowner, resident, business owner, or government official)

Straight pipe - Delivers wastewater directly from a building, e.g., house or milking parlor, to a stream, pond, lake, or river.

Total Maximum Daily Load (TMDL) - a pollution "budget" that is used to determine the maximum amount of pollution a waterbody can assimilate without violating water quality standards. The TMDL includes waste load allocations (WLAs) for permitted point sources, load allocations (LAs) for nonpoint and natural background sources, plus a Margin of Safety (MOS). A TMDL is developed for a specific pollutant and can be expressed in terms of mass per time, toxicity, or other appropriate measures that relate to a state's water quality standard.

Transitional land use - areas of sparse vegetative cover (less than 25 percent of cover) that are dynamically changing from one land cover to another, often because of land use activities. Examples include forest clearcuts, a transition phase between forest and agricultural land, the temporary clearing of vegetation, and changes due to natural causes (e.g. fire, flood, etc.).

Wasteload allocation (WLA) - the portion of a receiving water's loading capacity that is allocated to one of its existing or future permitted point sources of pollution. WLAs constitute a type of water quality-based effluent limitation.

Water quality - the biological, chemical, and physical conditions of a waterbody. It is a measure of a waterbody's ability to support beneficial uses.

Water quality standards - a group of statements that constitute a regulation describing specific water quality requirements. Virginia's water quality standards have the following three components: designated uses, water quality criteria to protect designated uses, and an anti-degradation policy.

Watershed - area that drains to, or contributes water to, a particular point, stream, river, lake or ocean. Larger watersheds are also referred to as basins. Watersheds range in size from a few acres for a small stream, to large areas of the country like the Chesapeake Bay Basin that includes parts of six states (see, drainage basin).

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